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ABSTRACT

This document outlines the existing conditions of school buildings and their vulnerability to natural hazards on the islands of Antigua and Barbuda, and makes recommendations on how to better protect them from these hazards. Profiles of the schools are detailed and the roles and responsibilities of the various organizations concerning construction, reconstruction, retrofitting, and damage repair are highlighted. Also included is an assessment of the types and prevalence of specific natural hazards that can affect the islands and the vulnerability of each school to these hazards. The existing policies pertaining to school buildings and shelters are addressed along with traditional building practice, site selection and specifications, design criteria, maintenance, and community involvement. Final comments explore: (1) the processes in school infrastructure including design, construction, retrofitting, and repair; (2) the organizations responsible for various projects such as retrofitting, design, site selection, and financing; and (3) existing country plans and strategies in disaster planning. Included is a list of recommendations to make school buildings less vulnerable to natural hazards. Appendices contain the mandates related to vulnerability reduction in the education sector and the survey forms used in the building assessment pilot study. (GR)

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ED 432 900

Antigua and Barbuda

National Plan to Reduce the Vulnerability of School Buildings to Natural Disasters

Government of Antigua and Barbuda

Organization of American States

Organisation of American States

USAID

United States Agency for International Development

E C H O

European Community Humanitarian Office

June 1998

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1.0 INTRODUCTION

1.1 Objective

The objective of this document is to look at the vulnerability of school buildings to natural hazards in Antigua and Barbuda. Special consideration should be given to school buildings because they often serve as shelters in times of disasters. This plan outlines the existing conditions in Antigua and Barbuda and makes recommendations on how to better protect them from natural hazards.

1.2 Use of this Document

This document is intended for use by the Ministries of Education and Public Works, the National Office of Disaster Services (NODS), the Board of Education, the Development Control Authority (DCA), as well as the Central Government as a whole. This plan paints a clear picture of the existing stock of school buildings and the roles and responsibilities of the organizations involved.

2.0 SCHOOL CONSTRUCTION SECTOR

2.1 Profile of School Buildings

There are 71 schools in Antigua and Barbuda, 39 government schools and 32 private institutions. Schools vary from two-story to single-story structures. Many use designer concrete blocks for ventilation while others have louvered windows or shutters. The basic materials used in construction are concrete, brick, mortar, timber, and corrugated zinc sheeting for roofs. Some schools built before 1970 have asbestos material in their roofs, however, this is gradually being replaced.

TABLE 1 List of Government Owned School Buildings

No.	Name of School	Location	No. Floors	Year Built
Primary Schools				
1	J.T. Ambrose	Centre of Island	1	Over 20
2	Liberta	South of Island	1	Over 20
3	Bolans	South West of Island	1	Over 20
4	Urlings	South West of Island	1	Over 20
5	Green Bay	South West of Island	1	Over 20
6	Five Islands	South West of St. John's	1	Over 20
7	Bendals	Bendals Village	1	Over 20
8	New Winthropes	Barnes Hill	1	Over 20
9	Cobbs Cross	South West of Island	1	Over 20
10	Parham	Parham Village	1	Over 20
11	Glanvilles	Glanvilles Village	1	Over 20
12	John Hughes	John Hughes Village	1	Over 20
13	Holy Trinity	Barbuda	1	Over 20
14	T.N. Kirnon	St. John's	1	Over 20
15	Bethesda	East of Island	1	Over 20
16	Buckleys	Centre of Island	1	Over 20

17	Golden Grove	St. John's	1	Over 20
18	Mary E. Pigott	Ottos (St. John's)	2	1980-81
19	Old Road	South of Island	1	Over 20
20	Pigotts	East of St. John's	1	Over 20
21	Willikies	East of St. John's	1	Over 20
22	Sea View Farm	Centre of Island	1	1987-88
23	Jennings	South of Island	1	1996
24	Pares	East of Island	1	1987-88
25	Cedar Grove	North of Island	1	Over 20
26	Freetown	East of Island	1	Over 20
27	Newfield	East of Island	1	Over 20
28	Swetes	South of Island	1	1990
29	Potters	East of St. John's	1	Over 20
30	Villa	St. John's	1	Over 20
Secondary Schools				
31	Ottos Comprehensive	St. John's	2	1973-75
32	Antigua Grammar	Old Parham Road	2	Over 20
33	Antigua Girls' High	St. John's	2	Over 20
34	Princess Margaret	Dickenson Bay Street	1	1955
35	All Saints	Centre of Island	2	1975
36	Clare Hall	East of St. John's	1	Over 20
37	Jennings	South of Island	2	Over 20
38	Pares	East of Island	2	Over 20
39	Holy Trinity	Barbuda	1	Over 20

2.2 Responsible Agencies and Collaborators for:

a. Design

Board of Education, Ministry of Education, Ministry of Public Works and Community Groups

The Ministry of Education and the Board of Education set out the criteria for the use of the school and the Ministry of Public Works provides the architectural and engineering specifications.

b. Construction

Ministry of Public Works, Board of Education, Health Department and Development Control Authority (DCA)

The Ministry of Education and the Board of Education provide funding, while the Health Department makes sure that all waste water and sewage is in its proper place. The DCA makes sure all building guidelines set out in the state are followed by the Ministry of Public Works who implements the construction and follow all guidelines.

c. Reconstruction after Destruction

Ministry of Public Works, Board of Education and the Ministry of Finance

The Board of Education provides funding for reconstruction and, if necessary, the Ministry of Finance. The Ministry of Public Works is responsible for reconstruction.

d. Retrofitting

The Ministry of Education, Board of Education and Community groups all have a role to play in the retrofitting of our schools/shelters.

Retrofitting requires collaboration between the Ministry of Education and the Board of Education and specified community groups.

e. Repair After Damage

Ministry of Public Works and Board of Education

The Board of Education and the Ministry of Public Works carry out repairs.

2.3 Building a Profile and Data Base Process

The Ministry of Public Works, the Ministry of Education and the Board of Education all have a vested interest in proper data base information which will provide them with the information necessary to analyze these structures for future development.

The task should be carried out jointly by the Ministry of Public Works, the Board of Education and the Ministry of Education. This will allow for the proper keeping of information and the update of the same. This will allow more efficient problem solving in our school maintenance programme.

3.0 PREVALENT NATURAL HAZARDS

3.1 Hurricanes

The impact of hurricanes is recorded in the archives of Antigua and Barbuda and dates back to 1642. However, in living memory, one often hears of the hurricanes of 1950/51. These hurricanes accounted for the total elimination of several villages. Injuries and deaths were reported to be as high as fifteen per cent of the population. The damage to the agricultural sector was extensive, which later resulted in extreme hardship for the inhabitants of the island, as agriculture was the main industry.

In recent times, Antigua and Barbuda has been struck by Hurricanes Hugo in 1989 and again by Luis and Marilyn in 1995. Although Hurricane Hugo did not impact on Antigua and Barbuda directly, the damage was fairly significant. This served as a wake up call for those Antiguans born after 1950/1. The damage to the school plants was fairly extensive as was the damage to other sectors of the economy.

Hurricane Luis, however, was the most destructive force of nature to grace this twin island state of ours in the memory of any Antiguan alive. In a small developing country with its population a mere 63,000 people, the estimated damaged caused by Luis was put at $500 million. This figure by itself gives an idea of the type of destruction the impact caused. Thirty-seven government schools and nine private schools out of a total of 71 were damaged. (As states earlier, there are 39 government schools and 32 private schools in the country.)

As a result, some schools were closed, as others had to share the facilities by way of a shift system. This was due in part to the nature of the damage to some of these facilities which ranged from roofs totally blown-off, windows and doors destroyed or badly damaged, flooding, etc.

Annex 10.5 contains additional information pertaining to hurricanes.

3.2 Earthquakes

Antigua lies in the Caribbean belt, where activities along the northern and eastern boundaries of the Caribbean plate cause the majority of earthquakes that we feel. Antigua and Barbuda is part of the tectonically active Circum-Caribbean belt

Records of the destructive earthquakes date back to 1819. However, the most recent was the earthquake of 1974, which caused wide spread damage and destruction to several buildings and the infrastructure costing millions of dollars.

For more information on seismic vulnerability, please consult William McCann's article, "On the Earthquake Hazards of Puerto Rico and the Virgin Islands" published in the Bulletin of the Seismological Society of America, Vol. 75, No.1. (February 1985): pp. 251-262.

3.3 Volcanic Eruptions

Many local residents are of the view that a volcanic vein is located beneath the historical landmark of the St John's Cathedral. However, the Seismic Research Centre in Trinidad and Tobago in a report submitted to NODS indicates that there is no scientific evidence to substantiate this claim.

Although Antigua has no known volcano, we are in very close proximity to Guadeloupe in the southeast, Dominica in the south-southeast and Montserrat in the southwest. All of these islands have volcanoes that can negatively impact on the way of life, for the people of Antigua and Barbuda if or when they erupt.

The Soufriere Hill volcano in Montserrat became active on the 18th July, 1995 and is located some 30 miles southwest of Antigua. Recently, Antigua has felt the effects of this volcanic eruption particularly

when there is a change in the wind direction. On at least one such occasion, schools had to be closed and most businesses operated at a level well below their usual scale.

3.4 Floods

There is no recorded data to indicate that in the past Antigua had any significant impact caused by flooding. In recent times however, certain development activities have brought cause for concern. The interference with some natural watercourse has caused severe flash flooding in some areas to a magnitude unfamiliar to these areas.

3.5 Droughts

History reveals that at least two attempts were made and abandoned before the European settlers eventually inhabited Antigua and Barbuda. This was primarily due to the lack of water on the island. In recent times, the droughts of 1984 and 1995 would be fresh in the memories of Antiguans and Barbudans.

In 1984, Antiguans witness the almost total collapse of the agricultural sector. The livestock industry suffered loss in the region of about 40 percent, and water had to be barged in from nearby Dominica. The contraction and expansion of soil due to dry and wet weather have some implications for the site selections of our schools/shelters and the building techniques used if we are to avoid or minimize negative impacts in the future.

Unlike other disasters, the effects of droughts are often very slow to detect and in some cases are not detected at all. Members of the agricultural sector tend to accept losses as a natural occurrence and are reluctant to attribute damage to drought.

Annex 10.3 contains additional information pertaining to rainfall.

3.6 Landslides

There is no evidence to indicate that Antigua had any significant landslide problems in the past. However, there are signs that this will change in the future as burning and other forms of clearing hillsides for agriculture and housing purposes indicates that the removal of hillside vegetation may result in slippage.

A small incident of slippage in the Fig Tree Hill Drive area occurred after Hurricane Luis. Soil erosion during flashfloods normally leaves its mark on the agricultural sector as important topsoil is often washed away.

4.0 VULNERABILITY OF SCHOOL BUILDINGS

4.1 Methodology

A pilot study was initiated to analyze the vulnerability of twenty selected properties in Antigua and Barbuda. The properties analyzed are listed in Table 2, a comprehensive profile of the properties is contained in section 4.2. Information pertaining to seismic vulnerability and the wind hazard was gathered using the survey found in Annex 10.8 and through interviews with key personnel including principals, teachers and other community members. The results of this survey will be available in September 1998.

4.2 Profile of Schools

1. JT AMBROSE PRIMARY SCHOOL

Location: All Saints Village (Centre of island)
Year constructed: Over 20 years
Years of major additions and changes: 1997

The buildings are single story pitched timber with metal sheeting roof (gable). Four of the buildings are constructed from reinforced concrete blocks. The other two buildings are constructed from timber. The Ministry of Public Works carries out maintenance. The buildings have been used as a community center and hurricane shelter.

Funding for the most recent buildings came from the Canadian International Development Agency (CIDA) and the Board of Education. The Board of Education provided funds in 1996-1997 for up grading.

2. LIBERTA PRIMARY SCHOOL

Location: Liberta Village
Year constructed: Over 20 years

The buildings are single storey reinforced concrete masonry with timber pitched roofs. The coverings are corrugated metal sheeting.

The Ministry of Public Works is responsible for the maintenance of the school building. The buildings have been used as a community centre and hurricane shelter.

3. BOLANS PRIMARY SCHOOL

Location: Bolans Village (South West of island)
Year constructed: Over 20 years

The building that comprises the compound is constructed from reinforced masonry blocks with the roof being pitched timber with metal sheeting. No major work has been done to the roof since it was constructed. In addition to housing the school, the building has been used as a hurricane shelter.

The Ministry of Public Works carries out the maintenance. Funds will be provided by the Board of Education for upgrading.

4. URLINGS PRIMARY SCHOOL

Location: Urlings Village (South of Island)
Year constructed: 1980-81

This facility consists of six reinforced concrete block buildings with pitched timber roofs with metal sheeting. Minor repairs were carried out after Hurricane Luis. In addition to housing the school, the buildings have been used as hurricane shelters.

The British Government provided funding to construct the school and the Ministry of Public Works maintains it.

5. GREEN BAY PRIMARY SCHOOL

Location: West of St. John's
Year constructed: Over 20 years

This facility consists of ten reinforced block buildings with pitched timber roofs and corrugated metal sheeting as covering. This facility suffered severe damage from Hurricane Luis. This facility is also used as a hurricane shelter.

The Board of Education and the Ministry of Public Works have carried out major rehabilitation work. The British Government will be funding an upgrade to this facility.

6. FIVE ISLANDS PRIMARY SCHOOL

Location: Five Islands Village (South West of St John's)
Year constructed: Over 20 years

This facility consist of two reinforced concrete buildings with steel rafters which support plywood ceiling and galvanized metal sheeting and five wood structures supported by concrete pillars. The approximate age of the main buildings is twenty (20) years with the wooden buildings constructed in the last three years. These buildings are mainly used for school and other community activities.

The Ministry of Public Works is responsible for the construction and maintenance of these buildings. Funds will be provided by the Board of Education for upgrading and on-going maintenance.

7. BENDALS PRIMARY SCHOOL

Location: Bendals Village
Year constructed: Over 20 years

This facility consists of five single storey buildings, which are constructed from reinforced masonry blocks. The roofs (gable) are mainly steel trusses, which support plywood ceiling and galvanized metal sheeting. The buildings are used mainly for school purposes, community activities and hurricane shelter.

The Ministry of Public Works is responsible for the construction and maintenance of this facility.

8. NEW WINTHROPES PRIMARY SCHOOL

Location: Barnes Hill
Year constructed: Over 20 years

This facility consist of two main buildings constructed from reinforced concrete masonry blocks with pitched gable roof with timber rafter support plywood ceiling and galvanized metal sheeting. These buildings are over twenty years old. The buildings are mainly used for school and other community activities.

The Ministry of Public Works is responsible for the construction and maintenance of this facility. The Board of Education provides funds for upgrading and on-going maintenance.

9. OTTOS COMPREHENSIVE SCHOOL

Location: Ottos (St John's)

Year constructed: 1973 1975

This facility consists of twelve buildings, six- two storey and six-single storey buildings, all of which are constructed from reinforced concrete masonry blocks. The roofs of these buildings are reinforced concrete. The buildings are used as a school and also a hurricane shelter.

The Ministry of Public Works is responsible for the maintenance of this facility. Funds have been secured from CDB for refurbishing and expansion.

10. ANTIGUA GRAMMAR SCHOOL

Location: Old Parham Road (St John's)
Year constructed: Over 20 years

The main building is an aged two storey structure with masonry concrete at the lower level and timber at the upper level. Ten other single storey buildings are also part of this facility. The roof is gable and hip constructed with timber rafters, which support boarded ceiling and galvanized metal sheeting. The buildings are used for other community activities in addition to housing a student population of 380.

The Ministry of Public Works carries out the maintenance of this facility. Funds have been secured from CDB for refurbishing and expansion.

11. ANTIGUA GIRLS HIGH SCHOOL

Location: St John's
Year constructed: Over 20 years
Years of major additions and changes: 1997

This facility has houses six (6) buildings with the main building being a two storey steel frame structure with timber cladding. Another two-storey building is constructed with reinforced concrete blocks. The remaining buildings are single storey wooden buildings. The roofs of the buildings are mainly timber with metal sheeting.

The Ministry of Public Works maintains this facility. Funds have been secured from CDB for refurbishing and expansion.

12. PRINCESS MARGARET SCHOOL

Location: Dickenson Bay Street (St John's)
Year constructed: 1955

There are twelve buildings on the compound most of which are constructed from reinforced masonry blocks, the exception being the Industrial Arts Block which is steel framed. The roofs of these buildings are gable constructed with timber rafters that support a plywood ceiling and galvanized metal sheeting. In addition to housing a student population of over 700 students, the facility is also used as a church, shelter, and for other community purposes .

The Ministry of Public Works is responsible for the maintenance of this facility. Funds have been secured from CDB for refurbishing and expansion.

13. COBBS CROSS PRIMARY SCHOOL

Location: South East of Island (St. Pauls)
Year constructed: Over 20 years

This facility consists of buildings constructed from reinforced concrete masonry blocks with pitched roofs with timber rafters supported by plywood ceilings and galvanized metal sheeting. These buildings are over twenty years old. The buildings are mainly used as school classrooms and for other community activities.

The Ministry of Public Works is responsible for the construction and maintenance of this facility. The Board of Education provides funds for upgrading and ongoing maintenance.

14. PARHAM PRIMARY SCHOOL

Location: Parham Village (North East of Island)
Year constructed: Over 20 years

This facility consists of five single storey buildings constructed from reinforced masonry blocks. The roofs being gable are constructed from timber rafters, which support plywood ceiling and galvanized metal sheeting. These buildings are over twenty years old and are used mainly for school purposes, community activities and as a hurricane shelter.

The Ministry of Public Works is responsible for the construction and maintenance of this facility. The Board of Education will provide funding for maintenance.

15.GLANSVILLES PRIMARY SCHOOL

Location: Glanvilles Village
Year constructed: Over 20 years

This facility consists of four-single storey buildings with the main structural members being structural steel and reinforced concrete blocks. The gable roof is a structural steel portal frame, which supports metal purlins and a plywood ceiling. The buildings are used for community activities and as hurricane shelters in addition to housing the school.

The Canadian Government was responsible for the construction of this facility while the Ministry of Public Works is responsible for its maintenance. The Board of Education provides funds for upgrading and on-going maintenance.

16. JOHN HUGHES PRIMARY SCHOOL

Location: John Hughes Village
Year constructed: Over 20 years

This facility is housed in two-single storey structures, which are constructed from structural steel columns and reinforced concrete masonry blocks. The gable roofs are steel portal frames which support metal and timber purlins which in turn support plywood ceilings and galvanized metal sheeting. The buildings are used for community activities and as hurricane shelters in addition to housing the student population.

The Ministry of Public Works carries out the construction and maintenance. The Board of Education provides funds for upgrading and on-going maintenance.

17. HOLY TRINITY PRIMARY SCHOOL

Location: Barbuda
Year constructed: Over 20 years

This facility consists of three reinforced concrete block buildings. The roofs are pitched timber with corrugated metal sheeting. The buildings are used for community activities and as hurricane shelters.

The Barbudan Council and the Board of Education are responsible for the maintenance of the buildings.

18. HOLY TRINITY SECONDARY SCHOOL

Location: Barbuda
Year constructed: 1970-73

The facility consists of five reinforced concrete block buildings with pitched timber roofs. The buildings are used for community activities in addition to school use. The British Government provided funds to build this school.

19. T.N. KIRNON PRIMARY SCHOOL

Location: St. John's
Year constructed: Over 20 years

This facility consists of one two storey buildings which is constructed from stone masonry and timber upper floor. The roof is pitched timber with corrugated metal sheeting. Four additional reinforced concrete blocks were constructed in 1982 with funding provided by the British Government. The facility is mainly used for community activities in addition to its use as a school.

Maintenance and upkeep are carried out by the Ministry of Public Works.

20. NODS BUILDING

Location: St. John's
Year constructed: Over 20 years

This facility consists of one large building with three compartments constructed from reinforced concrete masonry blocks with a flat concrete roof on both the southern and northern ends of the building with the center having a pitched gable roof. The center upper portion of the buildings was stripped after damages caused by Hurricane Luis.

The Ministry of Public Works is responsible for maintenance of this facility. Funds for upgrading and ongoing maintenance are made available by the Ministry of Public Works.

TABLE 2

List of 20 shelters selected by the Government of Antigua and Barbuda to be surveyed and evaluated in the pilot study and their vulnerability to natural hazards

No.	Name of Building	Hurricane		Earthquake		Flood		Dr
		Low	High	Low	High	Low	High	Low
1	JT Ambrose Primary	X		X		X		X
2	Liberta Primary	X		X		X		X
3	Bolans Primary	X		X			X	
4	Urlings Primary		X	X		X		X
5	Green Bay Primary		X		X	X		X
6	Five Islands Primary		X	X			X	X
7	Bendals Primary	X		X			X	X
8	New Winthropes Primary		X	X		X		X
9	Ottos Comprehensive	X		X		X		X
10	Antigua Grammar		X	X		X		X
11	Antigua Girls High School	X		X			X	X
12	Princess Margaret Secondary		X		X	X		X
13	Cobbs Cross Primary	X		X			X	X
14	Parham Primary	X			X	X		
15	Glanvilles Primary	X		X		X		X
16	John Hughes Primary	X		X		X		X
17	Holy Trinity Primary		X	X			X	X
18	Holy Trinity Secondary		X	X			X	X
19	T.N. Kirnon Primary	X		X		X		X
20	NODS Building		X		X	X		X

5.0 POLICIES

Objectives: To develop and enforce building codes, to specifically address the design and construction of school buildings or shelters. The end product of this task should be the birth of a model building that can be duplicated and manipulated in any location.

5.1 Existing Policies that Pertain to School Buildings and Shelters

The Development Control Authority (DCA) is a government organization charged with the task of monitoring and regulating the construction industry. The DCA is guided by the Building Regulation Act, which contains building codes and guidelines for construction. These codes, however, do not contain any clauses that define an acceptable level of vulnerability to natural disasters of shelters or schools. Consequently, communities are put in a position where they are forced to use buildings for emergency shelters which were not originally designed for that purpose; a point which was reinforced after the last two hurricanes (Hugo 1989 and Luis 1995) where we experienced major destruction to many shelters and unnecessary discomfort and distress to the shelter occupants.

It is, therefore, imperative that, in an effort to safeguard life and property, the DCA immediately revisit its Building Code and address the shortcomings by specifying acceptable levels of vulnerability to natural disasters of all schools and shelters.

Such a task will require an investigation into the following:

a. Traditional Building Practice

The traditional details employed in the construction industry must be analyzed for performance standards and where they are found to be inadequate, new details must be developed to reduce the risk of destruction by earthquakes and hurricanes. For example: the practice of toenailing rafters and studs must be abandoned in favour of more efficient methods of fixing such as bolting and strapping rafters to each other and to the foundation.

b. Site Selection and Specifications

Where new schools or shelters are to be constructed, the site must be carefully selected according to specified guidelines to reduce vulnerability to natural disasters. Flood plains and exposed ridges and cliffs should be avoided in favour of more sheltered locations. A minimum high of 12" should be established above grade at the datum of all ground floor level.

c. Design Criteria

Provision must be made for the inclusion of the following facilities to all new shelters:

- Enclosed walkways must be provided linking shelter blocks.
- Hurricane shutters should be installed to all openings.
- Kitchen facilities must be provided.
- Sick infirmary with a minimum of two beds is a necessity.
- Cistern raised a minimum of four feet [4'] above grade equipped with electrical and manual water pump should be provided to all shelters.
- Auditoriums to accommodate large gatherings should be provided.
- Adequate bathrooms, which are directly accessible without having to leave the shelter block, should be provided.
- Drains must be provided to prevent flooding from rising surface water. In addition, a minimum height above grade should be specified for all schools/shelters. (See policies sub-paragraph B)
- It is imperative that provisions for the handicapped be made, such as ramps, rails and special bathroom facilities.
- Each shelter must be provided with generators, first aid kits, fire extinguishers etc.

- Where existing buildings must be used as shelters, retrofitting exercises must be carried out to bring these buildings to an acceptable standard based on the above mentioned guidelines.

d. Maintenance

The maintenance of schools is the responsibility of the Ministry of Education supported by the Board of Education, and the Ministry of Public Works. The Ministry/Board of Education must clearly define its role as it relates to private schools.

Maintenance should be preventative rather than the practice of repairing after damage is done. A recurring budget must be provided for this purpose. The establishment of a maintenance team and the identification of a supplier to provide materials in an adequate and sustained manner must be put in place.

The policy of assistance to private schools must be clearly defined and communicated to them so that access to assistance from the Board of Education can be realized.

e. Community Involvement

Community action groups must become an integral part of the Central Government's policymaking to ensure that they have input in decisions taken that will ultimately affect them during emergency situations.

There is much concern over the ability of the DCA to adequately enforce the building codes and any guidelines that may be adopted. It is imperative to the integrity of our schools/shelters, that DCA is provided with the necessary tools to be able to enforce the building codes. This may require new legislation, additional staff and training, and a strong commitment from government. Unless the DCA is empowered to implement the building codes, no new policies can or will have the desired effect.

6.0 PROCESSES

6.1 Diagrams of Planning Processes in School Infrastructure

a. Design

The government, through the Ministry of Education, commissions a plan for the design and construction of a school plant. This is done after much careful assessment of the educational and social needs of a particular community.

With prior and present knowledge of the physical aspects of the designated area for the school plant, the Board of Education then puts out a tenders notice for suitable designers and contractors to develop the project. In some instances, the Ministry of Public Works may be contracted to carry out the developments or a part thereof. Such a plan would involve a number of units, their location and sizes along with the classrooms and other facilities deemed necessary.

However, it should be noted that most of our schools are gifts from foreign governments with little or no local input into their design and construction, and in most cases, are inadequately designed to be used as emergency shelters.

As a part of the government's programme to reduce the vulnerability of school plants, the CDB has recently approved a loan package designed to carry out improvement exercise for nine government schools.

Design of schools is also based on the amount of financing that is available which, in most cases, determines to a large extent the vulnerability of these structures to natural and or man made hazards, especially during a disaster.

Some schools are built in low-lying areas to avoid the direct impact of hurricanes. For example, the Cedar Grove School, while others are constructed outside the heart of the community.

Most of our schools plants have been constructed using inadequate design of the roofs, which gave rise to over three-quarters of them loosing their roofs in hurricanes Marilyn and Luis. The gable roof design has proven to be vulnerable to hurricane force winds.

b. Construction

The Architectural Design and Construction Division in the Ministry of Public Works is responsible for ensuring that all relevant elements of the building code and any other considerations are taken under advisement to ensure that school buildings are built to the acceptable levels of vulnerability.

c. Reconstruction

Reconstruction should be carried out only after all the necessary assessment has been done. During all stages of reconstruction, every effort must be made to apply mitigation measures.

This should only be undertaken after the type and cause of damage is ascertained to the roof, and other parts of the super-structure. Existing construction should be improved by using adequate retrofitting measures. For example, larger and stronger materials, and safer fastening methods should be used. The reconstruction of a unit should not to be done in the same fashion as previously construction if the building was initially inadequate. However, the uniformity of the structure should be maintained.

d. Retrofitting

Retrofitting is the implementation of major repairs to a structure for the purpose of changing or modifying the construction to withstand the effects of potential hazards. An inventory of retrofitting exercises should be kept on all building. Retrofitting must be carried out as a result of much planning and always for maximum benefit.

Data should be kept on natural hazards that have affected the school infrastructure, so that retrofitting can be carried out with an aim to prevent any such problem from reoccurring. A division should also be created within the Ministry of Public Works to deal specifically with the maintenance and construction of all government schools, based on certain guidelines dealing with the reduction of the vulnerability of school infrastructure to natural hazards.

Drawings showing all connections of services, shutoff valves, main switch, plan of the buildings, and utility and plumbing plans should be kept at the school. Ideally, a trained individual should be posted at the school/shelter to cope with any sort of accident, etc.

e. Repairs

Repairs should be carried out frequently, especially where the building suffered structural damages cause by settlement, earthquakes, heavy rains, and/or droughts. A period of 12 to 18 months should be use as a yardstick for engineers to check school/shelter buildings for maintenance of the superstructures, while a

more frequent check can be done for other repairs.

An inventory of all government schools is presently being conducted to establish the need for retrofitting. This information will be used to put in place some form of prioritized listing, so as to improve the present condition of all schools. The basic necessities for emergency situations, such as a kitchen, bathrooms, water tanks, cistern, electrical generators and other vital resources must be put in place.

6.2 Building Capacity

School buildings are used for quite a number of different activities. With this in mind, they should be designed and constructed owing to this situation. Building capacity is determined by its design and construction, rather than by its size. Most of our schools are designed to accommodate children and not adults. During emergency situations, these facilities are stretched beyond their capacity to accommodate the accompanying adults. This places the infrastructure under severe pressure and actions must be taken to correct this problem.

7.0 PROJECTS

7.1 Mitigation and Retrofitting

Mitigation, retrofitting and repairs are the responsibility of the Ministry of Education, supported by the Ministry of Public Works, and the Board of Education. In the areas of preventative maintenance, we should upgrade these facilities to allow for better functioning of the school plants. By doing this on a regular basis, the cost of retrofitting can be tremendously reduced. Failure to mitigate and retrofit could lead to excessive spending in the future which will far outweigh the regular mitigation and retrofitting costs if done on a timely basis.

7.2 Design

The design of schools is the responsibility of the Ministry of Public Works with the specifications given by the Ministry of Education. The construction criteria is set out by the Ministry of Public Works, Design and Construction Division, which deals with the engineering of the structure to meet the specified building code and all architectural needs.

7.3 Site Selection

Site selection is normally done by the Ministry of Education based on the availability of land in the selected area. This practice should be discontinued and sites for schools should have specific guidelines to relieve vulnerability to natural hazards such as floods, hurricanes, earthquakes, etc. See Section 5.

7.4 Financing

Schools are financed through several sources, government, CDB and donor agencies. Funding by CDB and donor agencies is given with specific guidelines set out as to what the responsibilities of the government are relative to the project. In most cases, the funding agencies normally provide government with a turnkey project, which does not allow local input at the design stage. This practice must be discontinued to allow for local vulnerability and mitigation concerns to be interjected.

7.5 Community Involvement

Community involvement allows objective organizations and individuals the opportunity to represent their community. These individuals bring with them a wealth of knowledge in a variety of subject areas, which can enhance the overall development of the community.

8.0 PREPAREDNESS

8.1 Existing Country Plans and Strategies

There is no disaster plan in the Ministry of Education. There is, however, a broad National Disaster Plan. In addition, the National Emergency Operation Center (NEOC) guidelines for Antigua/Barbuda are in place.

There is a need for a disaster plan within the Ministry of Education, the following guidelines are suggested:

- Special emphasis must be placed on hurricanes and earthquakes. This does not exclude other hazards, e.g. natural and man-made hazards or catastrophes.
- This plan should seek to ensure that the necessary mitigation measures play a more significant part in our development based on the hazards that threaten Antigua and Barbuda.

Strategies:

- Dialogue must first take place between the key agencies involved including: the Ministry of Public Works, Ministry of Education, Development Control Authority (DCA), National Office of Disaster Services (NODS), the Board of Education, teachers and representatives from parent/teacher associations.
- The Government Printery, the Curriculum Development Office and the Board of Education could team up to print such a plan.
- Establish a process to cover Who? What? Where? When? How? and Why?
- Establish a working committee to prepare a draft plan for the Ministry of Education. The working group should be empowered to draft other personnel with the necessary expertise. (government and private sector)
- The draft must be submitted for approval to the appropriate authority, that is, the Cabinet of Antigua and Barbuda. Upon acceptance and approval, the document should be distributed to all schools, public and private.

8.2 The Role of Teachers and Students

- Should seek to implement the School's Disaster Preparedness Plan.
- Should seek to identify any weaknesses in the plan and offer suggestions for improvement.
- Should engage in regular drills to concretize their roles and functions.
- A link should be established with the Shelter Manager/NODS re: areas designated for use as shelters. (Some areas would need to be sealed off in an effort to protect furniture and/or delicate equipment, machinery and records etc.)
- Teachers should take on the roll of early detection and report any factors that impact negatively on the safety or the integrity of the designated school/shelter.
- Students should be educated as per the use and care of existing facilities.
- Teachers and students need to be sensitized as to their roles and functions in the execution of specific drills and any other related disaster management activities.

8.3 Links to Curriculum Development

The prevalence of natural disasters and the impact they have on our lives should be integrated into the existing school curriculum. A more permanent place in the overall educational system for this subject should be found with emphasis placed on those natural hazards that are known to affect Antigua and Barbuda.

An option would be to include this subject in the Social Studies Programme. Beneficiaries would be at all levels (kindergarten, primary schools, secondary schools and Antigua State College).

8.4 Links to Community Involvement

- Persons in the community should act as the custodians of these facilities.
- At least one community centre should be constructed in each of the seventeen (17) disaster districts to be use as shelters, thus relieving the wear and tear on school buildings.
- Residents should share the responsibility of protecting/securing school buildings and the properties.

9.0 RECOMMENDATIONS

1. Buildings should be constructed at least 12 inches above grade.
2. Bearing capacity of the soil should be taken to determine type of foundation and building technique.
3. Adequate reinforcement should be used such as bolts, clamps, straps, etc.
4. Grade-A materials should be used when constructing wooden buildings and a minimum gage of 24 galvanized sheeting should be used for roofing construction.
5. Design for proper ventilation and lighting must be taken into consideration and, if necessary, special venting for stormy weather to relieve pressure.
6. Each building should have independent toilet facilities.
7. Decorated blocks should not be used in the construction of school buildings without due thought to the use of the building, especially in times of disasters.
8. Construction of school roofs should be much steeper than present and be of hip roof design. Where gable is used, a parapet wall may be considered.
9. Sizes of roofing materials should be of larger cross sections and avoid using two by four rafter and wall plates.
10. Where possible, metal doors should be used.
11. Keen attention should be paid to the layout of infrastructure such as roads, drainage, recreation, parking, agriculture and science areas, etc.
12. Due consideration must be given to the environment and its protection.
13. The maintenance team must be multi-skilled, with responsibility for the maintenance of all government schools.
14. The policy of site selection, design, soil testing and collaboration between all principle parties must be adhered to.
15. The present policy of a sinking fund instead of insurance coverage for schools is one that, if properly administered, could have a positive impact on the education system. This responsibility should be given to the Board of Education.
16. The necessary support must be given to NODS to complete a Disaster Preparedness Plan for the Ministry of Education. Once a draft is complete, all schools must develop their own, school specific plan.
17. Future school construction must be carried out based on this plan whether it is financed with local

funds, grants from foreign agencies or governments, be it private or government.

18. The collection of school vulnerability data must be completed by 1st July, 1998, for all schools in Antigua and Barbuda and entered into the computer system at the Ministry of Public Works, the Board of Education and the Ministry of Education. It should be updated every nine months.
19. Over the next eighteen months to three years, a vulnerability study must be carried out on all government buildings, and the data computerized for further use in a retrofitting programme.
20. Profiles of school buildings should include the date of construction, vulnerability analysis to specific hazards, a maintenance update, history of damages caused by hazards, construction specifications and any other relevant information.

10.0 ANNEXES

10.1 Map with the Location of Public Schools on Antigua

(Oversized, not included)

10.2 Mandates Related to Vulnerability Reduction in the Education Sector

Permanent Council of the OAS, CP/ RES 546 (834/90). October 10, 1990

> Resolution 3: To encourage member states to make natural hazard management and disaster relief integral components of their socio-economic development activities.

International Decade for Natural Disaster Reduction 1990-2000 (IDNDR) which was proclaimed by the General Assembly of the United Nations by Resolution 44-236.

Permanent Council of the OAS, CP/RES 593 (922/92). October 28, 1992

> Resolution 4: To encourage member states to undertake natural hazards vulnerability reduction programs as an integral part of their efforts to alleviate conditions of poverty and underdevelopment and achieve sustainable economic growth.

Declaration of Cartagena, Interamerican Conference on Natural Disaster Reduction. March 21-24, 1994

> Recommendation 2: In the understanding that such vulnerability is one of the shortcomings of underdevelopment and environmentally- harmful actions, it is essential to co-opt the political willingness to recognize that such vulnerability should be among the explicit objectives of sustainable development planning and an indicator of environmental impact accountability. The development of monitoring techniques and the tallying of disaster vulnerability factors must be seen as essential tools for disaster prevention and mitigation.
>
> Recommendation 3: There is a need for eliciting greater community participation to gain greater in-depth understanding of individual and collective perceptions on such developments and their attendant risks and to assess the cultural and organisational features of the societies,

aside form their behaviour and relationship with their physical and natural environment, which may hamper or enhance prevention and mitigation as well as those that encourage or hinder the protection of the environment for the development of future generations; these being fundamental aspects in the definition of effective and efficient resources to mitigate the impact of the disasters on the region.

Recommendation 5: Given the importance and validity of cultural aspects during disasters, there should be the strengthening and encouragement for educational programs for the population and training programs for researchers, planners, experts and officials so as to provide them with adequate, diversified knowledge of the realities in the region in order to incorporate preventive aspects not in the culture.

CIECC (Inter-American Council for Education, Science and Culture), OAS/RES 1995

Declaration of Santa Cruz de la Sierra and Plan of Action for the Sustainable Development of the Americas. October 1996

Initiative 6: Promote the inclusion of disease outbreak response and disaster planning, preparedness, and mitigation in national development plans; seek to establish, as appropriate, regional emergency response teams and regularly test contingency plans; and promote the establishment of appropriate building construction codes that include regulatory and enforcement mechanisms through the sharing of technical information and expertise.

Initiative 45: Foster the inclusion of sustainable development in urban development plans, including mechanisms for evaluating the environmental impact.

Interamerican Program for Sustainable Development (PIDI) of the OAS. June 25, 1997

Resolution 4.1b iii: Promote the exchange of information for supporting established networks for the exchange of experiences and methods in the forecasting and mitigation of natural disasters, so that this topic can be incorporated into national development programs.

Resolution 4.1 c.Provide co-operation for:

i) Curriculum innovation and adaptation to incorporate the environment and the concept of sustainable development into regional programs of basic education and education work.

iii) The incorporation of the topic of natural hazards mitigation in national development plans, the encouragement of the adoption of appropriate building codes, and the preparation, strengthening of regional disaster relief plans.

iv) The co-ordination of activities and services of projects supporting the preparation of vulnerability profiles and the preparation of sectoral investment plans to reduce vulnerability to natural disasters.

10.3 Survey Forms used in the Pilot Study

- **Seismic Hazard Assessment Form Part I**
- **Seismic Hazard Assessment Form Part II**

- **Wind Hazard Assessment Form**

10.4 Information of Rainfall

Description of Monthly Moisture Conditions*

Index	Character of the Weather	Decrease in Rainfall %
4.0 or more	Extremely Wet	
3.00 to 3.99	Very Wet	
2.0 to 2.99	Moderately Wet	
1.00 to 1.99	Slightly Wet	
0.99 to –0.9	Nearly Normal	
-1.0 to –1.99	Mild Drought	10%
-2.0 to –2.99	Moderate Drought	20%
-3.0 to –3.99	Severe Drought	30%
-4.0 or less	Extreme Drought	40%

Scenario – Drought

Baseline Year – 1995	40.98"	Normal	40.98"
2006	5%	Slt. Drought	≤ 38.93"
2016	10%	Mild Drought	≤ 36.88"
2030	15%	Mod. Drought	≤ 32.78"
2040	20%	Mod/Severe Drought	≤ 30.74"
2055	25%	Severe Drought	≤ 28.69"
2080	30%	Extreme Drought	≤ 24.50"

* Derived from Rooys Drought Index

Monthly and Yearly Rainfall Totals for the Meteorological Office V.C. Bird International Airport

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10.5 Tropical Cyclones Diagram

(Oversized, not included)

10.6 Tropical Storms/Hurricanes which Affected Antigua 1882 to 1992

August 1871
Antigua devastated, people emigrated to Trinidad and Guadeloupe

September 1899
damage to labourers

1924
two hurricanes hit Antigua, Country Pond flooded and split Nevis Street in two

1928
moderate damage

August 1950
two hurricanes – August 21 – 100 mph and August 31 – 165 mph, 1,348 houses destroyed and 2,343 damaged

September 1989
Hurricane Hugo – full violence not felt, but winds recorded to 110 mph, 75 homeless

October 1990
Hurricane Klaus – passed just north of Barbuda with winds at 50 mph with gusts up to 70 mph, minimal to moderate damage.

Note: Hurricanes were not officially named until the early 1950s.

Seismic Vulnerability Assessment

FIELD SURVEY GUIDE - PART 1

Name of Facility:

ID Number:

Member Information:

Member	Plan dimensions	Concrete block strength	Concrete strength	Reinforcement grade & %	Structural steel grade	Timber grade	Commen
Main foundations							
Columns							
Walls							
Beams							
Slabs							
Rafters							
Purlins							
Roofing							

Photographs:

- North elevation
- East elevation
- South elevation
- West elevation

Structural Systems (longitudinal)

- Load-bearing walls
- Braced frames
- Column and beam
- Mixed systems (describe)
- Soft storeys
- Short columns

Structural Systems (transverse)

- Mixed systems (describe)
- Soft storeys
- Short columns

School	ID number	Direction	Number of storeys	Total floor area	Column area at base (above grade)	RC wall area at base (steel columns)	Masonry wall length at base
		T L					
		T L					
		T L					
		T L					
		T L					

Seismic Vulnerability Assessment

Field Survey Guide—Part 2

School

ID Number

Column dimensions													
		1T	1L	2T	2L	3T	3L	4T	4L	5T	5L	6T	6
A	3rd storey												
	2nd storey												
	1st storey												
B	3rd storey												
	2nd storey												
	1st storey												
C	3rd storey												
	2nd storey												
	1st storey												
D	3rd storey												
	2nd storey												
	1st storey												

Wall dimensions - Longitudinal													
		1-2	1-2	2-3	2-3	3-4	3-4	4-5	4-5	5-6	5-6	6-7	6-
		length	thickness	length	thickness	length	thickness	length	thickness	length	thickness	length	th
A	3rd storey												
	2nd storey												
	1st storey												
B	3rd storey												
	2nd storey												
	1st storey												

C	3rd storey												
	2nd storey												
	1st storey												
D	3rd storey												
	2nd storey												
	1st storey												

Wall dimensions - Transverse

		1	1	2	2	3	3	4	4	5	5	6	6
		length	thickness	length	thickness	length	thickness	length	thickness	length	thickness	length	th
A-B	3rd storey												
	2nd storey												
	1st storey												
B-C	3rd storey												
	2nd storey												
	1st storey												
C-D	3rd storey												
	2nd storey												
	1st storey												
D-E	3rd storey												
	2nd storey												
	1st storey												

Sketch

Line sketches should be provided at each floor level indicating:

- Columns
- Reinforced concrete (RC) walls and
- masonry walls.

Steel columns should be noted on the sketches and their overall dimensions stated in the table. In general, the walls should be shown only when they are continuous from floor to floor.

Hurricane Vulnerability Assessment

FIELD SURVEY GUIDE

Building Data

1. Name of Facility
2. Address
3. ID Number
4. Surveyor's Name
5. Survey Date
6. Year Constructed
7. Years of Major Additions or Changes
8. Was building formally engineered?
    - Yes
    - No
    - Do not know
9. Number of Storeys
10. Windstorm Loss History (Add separate sheet for additional details if necessary)
11. Surveyor's Comments (Add separate sheet for additional details if necessary)

Environment

1. Is there potential of debris from metal or wooden buildings, trees, loose material or roofing within 300 ft radius?
    - Yes
    - No
2. What is the type of surrounding terrain?
    - Coastal
    - Open field
    - Town
3. What is the type of topography?
    - Flat or gently undulating
    - Hillside or ridge
    - Promontory or cliff

Roof Envelope

1. Indicate the geometry of the roof:
    - Flat
    - Gable
    - Hip

- Other (describe)

2. What is the primary roof support system (supported at the exterior walls)?

   - Reinforced concrete
   - Steel beam
   - Steel truss
   - Open-web steel joist
   - Tapered steel beam
   - Wood truss
   - Wood beam or rafter
   - Other (describe)

3. Is there a positive anchorage system (such as hurricane straps) connecting the roof system at the exterior walls?

   - Yes
   - No
   - Do not know

4. What materials are used for the roof deck?

   - Cast-in-place concrete slab
   - Precast concrete
   - Metal deck
   - Wood battens
   - Plywood
   - Wood close boarding
   - Other (describe)

5. What type of roof covering is used?

   - Built-up roof with gravel
   - Standing seam metal roof
   - Metal profiled sheets
   - Asbestos cement sheets
   - Single-ply membrane
   - Tile roof
   - Timber shingles
   - Asphalt shingles
   - Other (describe)

6. What is the age of the roof covering?

   - Less than 5 years
   - 5 to 10 years
   - 11 to 15 years
   - 16 to 20 years
   - greater than 20 years
   - Do not know

7. Are there skylights or ventilators on the roof?

   - Yes
   - No

Wall Envelope

1. What is the primary vertical load resisting system at the exterior walls?

   - Reinforced concrete
   - Steel
   - Reinforced masonry
   - Unreinforced masonry
   - Wood
   - Other (describe)

2. What is the percentage of wall area covered by glass or mesh or open blocks?

   - 0% to 5%
   - 6% to 20%
   - 21% to 60%
   - Greater than 60%

4. Are the glass or mesh or open blocks provided with permanently installed shutters?

   - Yes
   - No

4. Indicate the type of cladding (other than in 2 and 3 above) used

   - Reinforced concrete block masonry
   - Unreinforced concrete block masonry
   - Precast concrete elements
   - Stone panels
   - Metal panels
   - Wood
   - Other (describe)

6. Indicate the type of external doors in the building

   - Metal panels
   - Solid wood (incl T&G)
   - Hollow-core plywood
   - Solid-core plywood
   - Other (describe)

Other Considerations

1. Are there awnings, canopies, covered walkways or carports?

   - Yes
   - No

2. What wind code was used for the design of the building?

   - BNS CP28 - Code of Practice for Wind Loads for Structural Design
   - CUBiC Part 2 Section 2 - Structural Design Requirements, Wind Loads
   - BS 6399 Part 2 - Code of Practice for Wind Loads. Year?
   - ASCE 7 - Minimum Design Loads for Buildings and Other Structures. Year?
   - South Florida Building Code. Year?

3. What damage was suffered by the buildings due to Hurricanes Luis and Marilyn in 1995? (Add separate sheet for additional details if necessary)

4. What types of repairs or types of reconstruction have taken place? (Add separate sheet for additional details if necessary)

5. What standards (with reference to wind and earthquakes) were used in the repairs or reconstruction? (Add separate sheet for additional details if necessary)

6. Surveyor's comments (Add separate sheet for additional details if necessary)